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ABSTRACT

This speech, presented by the U.S. Secretary of Education, speaks to mathematics educators about the need to reach for high standards of learning in mathematics as an ever more important part of preparing students for an increasingly complex global economy. One of the major concerns is increased polarization and dissension about how mathematics is taught. Energy employed in these battles should be spent on a crusade for excellence in mathematics for every student. Such a crusade should include building a culture of learning. This involves raising standards of teaching and learning in elementary through secondary schools, particularly in the middle school years when American students begin to lag behind students in other countries; developing a voluntary national test in eighth grade mathematics; and making sure that mathematics teachers have the training and commitment to teach mathematics well and understand how to blend different teaching approaches. Changes in teacher education are also necessary. For example, courses in schools of education must be redesigned to focus on the rigorous mathematical content that is tied to the content that teachers will teach. Further, more partnerships should be forged between educational institutions, teachers, technology centers, and other community sources of learning. (PVD)

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Speeches and Testimony

Remarks of Richard W. Riley
U. S. Secretary of Education

"The State of Mathematics Education: Building a Strong Foundation for the 21st Century"

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Conference of American Mathematical Society and Mathematical Association of America

Thursday, January 8, 1998

Good morning, ladies and gentlemen. It is a pleasure to be here. I want to especially thank Gail Burrill for agreeing to switch her time slot with me, and John Ewing, Sam Rankin, Laura Todd and others who have helped make this logistical change possible.

I have to say that it is somewhat intimidating speaking to such an intellectually impressive group. When I saw that I was speaking among powerhouse lectures with titles like "Kleene algebra with tests" and "Non-linear wavelet image processing" I got a little worried that perhaps I should add some words like "algorithm," "derivatives" or "integrals" to the title of my speech.

This is just as bad as one of the first speeches I gave as Secretary of Education. I was squeezed between two very well known PhDs -- Bill Cosby and Dr. Ruth, the sex therapist.

Now, I'm sure there's a connection between Dr. Ruth and what I want to talk about today. Maybe it's that, in this information age, mathematics is sexy.

Suffice it to say that when I saw the kinds of topics being discussed at this conference, I knew that this would be an audience that would be particularly receptive to a discussion about the need to reach for high standards of learning in mathematics as an ever more important part of preparing our students to compete and succeed in an increasingly complex global economy.

Quite simply, a quality mathematics education *must* be an integral part of today's learning experience. In order to succeed in our information based society, students must have a solid understanding of the basics -- reading, science, history, the arts -- and, smack at the center of this base of essential knowledge -- must be mathematics. As William James wrote, "The union of the mathematician with the poet, fervor with measure, passion with correctness, this surely is the ideal."

It should come as no surprise then, that almost 90 percent of new jobs require *more* than a high school level of literacy and math skills. An entry level automobile worker, for instance, according to an industry-wide standard, needs to be able to apply formulas from algebra and physics to properly wire the electrical circuits of a car. Indeed, almost every job today increasingly demands a combination of theoretical knowledge and skills that require learning throughout a lifetime.

That is why it is so important that we make sure that all students master the traditional basics of arithmetic early on -- as well as the more challenging courses that will prepare them to take physics, statistics and calculus in much larger numbers in high school and college.

A recent U.S. Department of Education report demonstrates that a challenging mathematics education can build real opportunities for students who might not otherwise have them.

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It found, for example, that young people who have taken gateway courses like algebra I and geometry go on to college at much higher rates than those who do not -- 83 % to 36%. The difference is particularly stark for low-income students. These students are almost three times as likely -- 71 percent versus 27 percent -- to attend college.

In fact, taking the tough courses, including challenging mathematics, is a more important factor in determining college attendance than is either a student's family background or income. This is the kind of direct link on which we need to build.

This undeniable and critical increase in the value of challenging mathematics for both individual opportunities and our society's long-term economic growth leads me to an issue about which I am very troubled -- and that is the increasing polarization and fighting about how mathematics is taught and what mathematics should be taught.

I will talk in more detail shortly about these so-called "math wars" in California and elsewhere. But let me say right now that this is a very disturbing trend, and it is very wrong for anyone addressing education to be attacking another in ways that are neither constructive nor productive.

It is perfectly appropriate to disagree on teaching methodologies and curriculum content. But what we need is a civil and constructive discourse. I am hopeful that we can have a "cease-fire" in this war -- and instead harness the energies employed on these battles for a crusade for excellence in mathematics for every American student.

One way to begin such a crusade is to start with the facts. Building on these facts, we can begin to spread the "gospel" of challenging mathematics -- not just to students, but to parents, teachers, and business and community leaders who, like yourselves, can and should play a critical role in building a culture of learning.

To begin with, we need to focus on raising the standards of teaching and learning in our K-12 schools, placing particular emphasis on improving the quality of mathematics education during these years. The payoff here affects all levels of society and we can not afford to give it short shrift.

Let me say that while our students aren't yet performing at the level we want, they are in fact doing better than many Americans think. Mathematics scores from the National Assessment of Education Progress (NAEP), the nation's report card, increased significantly from 1990 to 1996 at all levels tested. In addition, over the past two decades, more students are taking Advanced Placement mathematics courses, SAT and ACT mathematics scores are up, and more high school graduates are taking more years of mathematics -- in 1994, 51 percent of students completed three years compared to only 13 percent in 1982.

There is also some positive news when you compare our students with those of other nations. Here, I am speaking about the recent Third International Mathematics and Science Study (TIMSS), the most extensive international comparison of education ever undertaken. TIMSS compared the United States with up to 40 other nations in curriculum, teaching, and student performance at the fourth, eighth, and twelfth grade levels, and provides us with some real opportunities to reflect on and improve our own practices.

The good news is that U.S. fourth graders scored above the international average in mathematics and science -- in fact, they are near the very top in achievement in science and can compete with the best in the world.

TIMSS also revealed some areas where we need to improve and concentrate our efforts. Most troubling was the drop off experienced by our nation's eighth graders. The United States was the only country in TIMSS whose students dropped from above average performance in mathematics at the fourth grade to below average performance in mathematics at the eighth grade.

This is disappointing. But I believe the evidence of this "math gap" and the careful analysis TIMSS provides about why it has occurred gives us not only a wake-up call, but also a road map for improvement.

While the curriculum in our classrooms continues to focus on basic arithmetic in the years after fourth grade -- fractions, decimals, and whole number operations -classrooms in Japan and Germany have shifted their emphasis to more advanced concepts -- including algebra, geometry, and probability. Unfortunately, in too many cases our eighth grade curriculum looks like the curriculum of 7th grades elsewhere.

Why is our competitive position dropping in the middle grades? It's surely not because our kids can't master challenging material. And it's not because most don't know the basic skills of arithmetic. In fact, NAEP trend data, released in August of this year, shows that fully 79 percent of eighth graders "can add, subtract, multiply, and divide using whole numbers, and solve one-step problems," up from 65 percent in 1978.

These students are ready to move ahead to more challenging concepts. Of course, we should do whatever it takes to increase that 79 percent mastery of basic arithmetic concepts by the middle school years. Students should get the extra help they need, whether it is in after-school tutoring or some other way. But, at the same time, we need to raise our standards higher and ensure that all students are learning more challenging concepts in addition to the traditional basics.

That is one reason why we encourage the development of a voluntary national test in eighth grade mathematics. This test, which is based on NAEP, but which will provide individual student results, will help give all teachers, parents, and students the knowledge to evaluate achievement and develop challenging course work -- at world-class levels of performance in the basics as well as at more advanced levels of study.

States that have developed challenging standards of learning, aligned their assessments to those standards, and provided substantial professional development for teachers, have demonstrated improvement in student achievement.

In North Carolina, for example, students improved dramatically after development of challenging standards of learning and a statewide assessment system aligned to those standards. After beginning the decade near the bottom of the state NAEP mathematics rankings, North Carolina posted the greatest achievement gain of any state in the nation.

Indeed, how we engage larger numbers of students in challenging mathematics courses is an area worthy of discussion for scholars like yourselves. Whether high school students should take calculus classes or focus on statistics -- how to best integrate technology into the mathematics curriculum -- these are issues of real importance -- as opposed to politically inspired debates that will serve to sidetrack us from real improvement.

Each of you can play an important role in achieving this by being a constructive voice in encouraging the development of high state and local standards in mathematics.

And you can work with middle and high schools and other partners to help ensure that students get a rigorous college preparatory curriculum, particularly in mathematics, so they are prepared for college level work and careers with a future.

This leads me back to the need to bring an end to the shortsighted, politicized, and harmful bickering over the teaching and learning of mathematics. I will tell you that if we continue down this road of infighting, we will only negate the gains we have already made -- and the real losers will be the students of America.

We are suffering here from an "either-or" mentality. As any good K-12 teacher will tell you, to get a student enthused about learning, you need a mix of information and styles of providing that information.

You need to provide traditional basics, along with more challenging concepts, as well as the ability to problem solve, and to apply concepts in real world settings.

Different children learn in different ways and at different speeds. A good teacher will do whatever he or she can to reach that child and inspire him or her to learn.

That said, I believe that there is a "middle ground" between these two differing views of how to teach mathematics. In fact, if you take a close look at two opposing articles in the "The American Mathematical Monthly," by Professors Wu and Kilpatrick, and look beyond the rhetoric of this debate, I think you will see a good deal of common ground.

As Professor Wu asks, "who does not want to improve education?" Indeed, all Americans should be able to agree on much about mathematics. We all want our students to master the traditional basics -- to be able to add, subtract, multiply and divide, and be accurate and comfortable with simple mental *and* pencil and paper computation.

We all want our students to have the opportunity to master challenging mathematics -- which for K-12 students includes arithmetic and algebra, geometry, probability, statistics, data analysis, trigonometry, and calculus.

We also want our students to master the basics of a new information age -- problem solving, communicating mathematical concepts and applying mathematics in real-world settings as part of this challenging mathematics.

There are, of course, examples of questionable practices and teaching methods on both sides of this debate. As Professor Kilpatrick pointed out, "Change in education is notoriously complex, difficult, and unpredictable. Reform movements in mathematics education turn out neither as advocates hope nor as detractors fear. But these movements can energize those teachers who want, as Ed Begle once put it, to teach better mathematics and to teach mathematics better."

That is why we need your help to educate Americans on how important mathematics is in building a strong future for every American. All of you understand this and take it for granted. I would suggest, however, that this group is not a reflection of average America.

Perhaps a better description would be how the humorist Garrison Keilor described the children in his fictional hometown, Lake Wobegon -- "a place where all the kids are above average." Well, we need this above average community to focus on getting this very important message out to a society that is less mathematically oriented.

It is time we focused on the students and the interest of our nation -- on what really helps kids learn -- not on what the process for learning is called. I hope each of you will take the responsibility to bring an end to these battles, to begin to break down stereotypes, and make the importance of mathematics for our nation clear so that all teachers teach better mathematics *and* teach mathematics better.

This leads me to the final area I believe we need to focus on and in which all of you can play an especially important role -- and that is making sure that there is a talented, dedicated, and *prepared* teacher in every classroom. Every teacher should know not only the importance of a subject like mathematics, but also should have the training and the commitment to teach it well and to understand how to blend differing approaches.

Only in this way will we produce a generation that can learn the fundamentals and apply challenging mathematical concepts to the problems of the 21st century.

There are many wonderful teachers across the nation who give of themselves and who inspire students. Unfortunately, we are still falling short. We can do better, particularly in subjects like mathematics, which can require a special degree of skill and expertise.

Presently, 28 percent of high school mathematics teachers do not have a major or minor in mathematics. The average K-8 teacher takes three or fewer mathematics or mathematics education courses in college.

Furthermore, fewer than one half of 8th grade mathematics teachers have ever taken a course in the teaching of mathematics at this level. Equally distressing, the teacher qualifications are even lower in low income and minority schools.

We must do better. Recent studies have shown that student achievement is most influenced by teacher expertise, accounting for as much as 40 percent of the measured variance in students' mathematics achievement. According to NAEP, at grade eight, the teachers in the top-performing third of schools were almost 50 percent more likely to have majored in mathematics or mathematics education than the teachers in the bottom-performing third of schools.

It is time we took a good look at the way we train our teachers and the continuing support we give them. You have a direct impact on the future of the mathematics teachers this nation's schools turn out. According to the most recent CBMS [*Conference Board of Mathematical Societies*] survey figures available, at least 20 percent of mathematics majors completed high school teacher certification requirements. So the teachers of tomorrow are sitting in *your* classes today.

So I urge all of you to take a leading role in meeting this challenge -- and I offer several suggestions to achieve this. First, I hope you will make it a priority to prepare K-12 teachers. Work with your colleges' Schools of Education to improve the mathematical preparation of our teachers by ensuring that courses focus on rigorous mathematical content that is tied to the content that K-12 teachers will teach.

Second, it is time for you take a critical look at the curriculum and teaching methods used in undergraduate mathematics courses. It is only natural that a teacher will teach as he or she was taught. By improving this instruction we can simultaneously provide good examples and build for the future.

Third, we need to create more partnerships among your higher education institutions, teachers, and the many museums, technology centers, businesses, and other community institutions that are sources of learning. In this way we can take advantage of the other learning resources that are out there and help students see new ways that mathematics and other learning is applicable to daily life.

I'm pleased to note that some of this has already begun. The U.S. Department of Education is funding an effort by the MAA, the AMS, the National Council of Teachers of Mathematics, as well as other CBMS learned societies to develop over the next several years voluntary standards and a framework for the mathematical preparation of teachers of mathematics and for their induction into the profession. I hope you will work with them to expand this effort.

We need to have faith in our teachers who, when given the proper resources and training will teach to the highest standards. We need to have faith in our students who, when taught well at challenging levels, will be able to learn to the highest standards. And we need to have faith in the American public that given the facts about a subject as important as mathematics -- they will in turn put their creativity, discipline, energy and hard work to build a stronger future for America's students.

Make no mistake about it. There is a disconnect about mathematics in this country. A recent Harris poll revealed that while more than 90 percent of parents *expect* their children to go to college and almost 90 percent of kids *want* to go to college; fully half of those kids want to drop mathematics as soon as they can. It is time to impress upon a nation eager for learning and achievement the importance of advanced study in this field.

As the statistics I have related to you today make clear -- "Mathematics Equals Opportunity." There could be no more crucial message to send to the parents and students of America as we prepare for the coming century.

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